

- 21 Fleiss JL. Statistical methods for rates and proportions. New York: Wiley, 1981.
- 22 Efron B, Tibshirani RJ. *An introduction to the bootstrap*. London: Chapman and Hall, 1993.
- 23 Mander AP, Chataway J, Clayton DG, et al. Estimation of agreement in the presence of confounders. *Annals of Human Genetics* (submitted).
- 24 Curtius F, Speer H. Multiple Sklerose und Erbanlagen II Mitteilung. *Zeitschrift für die gesamte Neurologie und Psychiatrie* 1937;160:226–45.
- 25 Roberts DF, Roberts MJ, Poskanzer DC. Genetic analysis of multiple sclerosis in Orkney. *J Epidemiol Community Health* 1979;33:229–35.
- 26 Bulman DE, Sadovnick AD, Ebers GC. Age of onset in sibling pairs concordant for multiple sclerosis. *Brain* 1991; 114:937–50.
- 27 Doolittle TH, Myers RH, Lechrich JR, et al. Multiple sclerosis sibling pairs: clustered onset and familial predisposition. *Neurology* 1990;40:1546–52.
- 28 French Research Group for Multiple Sclerosis. Familial factors influence disability in MS multiplex families. *Neurology* 1999;52:1632–6.
- 29 Schapira K, Poskanzer DC, Miller H. Familial and conjugal multiple sclerosis. *Brain* 1963;86:315–32.
- 30 Weinshenker B, Armstrong H, Bulman D. A comparison of familial and sporadic MS. *Can J Neurol Sci* 1986;13:168.
- 31 Koch-Henrikson N. An epidemiological study of multiple sclerosis. *Acta Neurologica Scandinavica* 1989;80(suppl):1–123.
- 32 American Multiple Sclerosis Group. Clinical demographics of multiplex families with multiple sclerosis. *Ann Neurol* 1998;43:530–4.

NEUROLOGICAL STAMP

Phineas Gage and the science of brain localisation

An injury with an improbable outcome that occurred to a to a railway foreman on 13 September 1848 had an influence on the science of localisation of brain function. Phineas Gage was the foreman of a railway construction crew working just outside Cavendish, Vermont. He was the company's most capable foreman with a well balanced mind and shrewd business sense.

Gage was tamping an explosion charge. A tamping iron is a crowbar-like tool used to compact an explosive charge into the bottom of a borehole. The tamping iron used by Gage was 43 inches in length, 1.25 inches in diameter at one end, tapering over a distance of 12 inches to a diameter of 0.25 inches at the other end, and weighing about 13 pounds. Tamping involves packing of a charge into as small a space as possible at the point chosen for the explosion. An accidental explosion of the charge Phineas Gage had just set blew his tamping iron out of the borehole and through the left side of his skull. It entered a point first under his left cheek bone, exiting through the top of his head and landing some 25 to 30 yards away Gage was knocked over but may not have lost consciousness. Most of the left frontal lobe was destroyed.

The railway physician, Dr John Harlow, wrote to the *Boston Medical and Surgical Journal* (volume 29, Wednesday 13 December 1848)

"The accident occurred on 13 September last at 4 o'clock pm. The tamping iron had taken a direction upwards and backwards towards the median line, penetrating the integuments, the masseter and temporal muscles, passing under the zygomatic arch and (probably) fracturing the temporal portion of the sphenoid bone, and the floor of the orbit of the left eye, entering the cranium, passing through the anterior left lobe of the cerebrum and making its exit along the median line, at the junction of the coronal and sagittal sutures, lacerating the longitudinal sinus, fracturing the parietal and frontal bones extensively, breaking up

considerable portions of brain, and protruding the globe of the left eye from its socket, by nearly one half of its diameter . . . I am informed that the patient was thrown on his back and gave a few convulsive motions of the extremities but spoke in a few minutes . . . I did not arrive at the scene of the accident till 6 o'clock pm . . . assisted by my friend Dr Williams . . . I passed in the index finger its whole length without the least resistance in the direction of the wound in the cheek, which received the other finger in a like manner A portion of the anterior superior angle of each parietal lobe, and a semicircular piece of frontal bone, were fractured, leaving a circular opening of about 3 inches in diameter . . . the iron which was found some rods distance, smeared with brain . . ."

Postinjury deterioration occurred with restlessness, deliriousness, and infection. Despite his horrific injury Phineas recovered. He could walk, speak, and had normal awareness. Despite exemplary work before his accident, his employer would not return him to his former position. He had become fitful, irreverent, grossly profane, and showed little deference for other workers. Impatient and obstinate yet capricious and vacillating, he was unable to proceed with any plans. According to friends he was "no longer Gage". He performed various odd jobs including caring for horses and often driving a heavily laden coach drawn by six horses.

Seizures started in February 1860. Gage died on 21 May 1860, 4 months after his first seizure after the injury. No postmortem studies were made. In 1867 his body was exhumed from San Francisco's Lone Mountain Cemetery. The skull and the famous tamping iron were delivered by his brother in law to Dr Harlow. These were donated to the Warren Museum at Harvard University School of Medicine.

In 1994 the case was revisited. A group of researchers who examined the skull with modern computer reconstruction techniques attempted to deduce the most likely trajectory of the tamping rod. They found that the areas of the neocortex damaged corresponded to the areas damaged in the frontal lobe syndrome.

On Sunday 13 September 1998 a cast bronze plaque commemorating Phineas Gage's injury was unveiled at Cavendish Town Green. The postmark, like the plaque, commemorates the 150th anniversary of the event. The first day cover also shows Dr John Martin Harlow

L F HAAS



I thank Dr T Hines for bringing this extraordinary event and the philatelic commemoration to my attention.